International Journal of Engineering & Technology, 7 (4.37) (2018) 57-62

International Journal of Engineering & Technology

Website: Www.Sciencepubco.Com/Index.Php/IJET

Research Paper

Water Quality Monitoring of Tigris River by Using (GIS)-Based Physicochemical Parameters in Baghdad, Iraq

Nadia Nazhat Sabeeh[1]*, Waleed M. Sh. Alabdraba[2], Ghadah Hasan Mohamed[3], Zainab B. Mohammed[4]

[1,2] *Environmental Engineering Department, Tikrit University, Tikrit, Iraq*
[3] *Technical Institute of Kirkuk, Northern Technical University, Kirkuk - Iraq*
[4] *Constructions and Building Department, Technology University, Baghdad – Iraq*
**Corresponding author E-mail: eng.nadianazhat@tu.edu.iq*

Abstract

Water quality deterioration has become an essential concern worldwide due to climatic changes and increased pollution. As a result, the available drinking water supply resources will receive its ration of this deterioration. This study was conducted to monitor the water quality of the Tigris River in eight different locations in Baghdad during the period between 2005 and 2013. Water samples were collected and analyzed for fourteen selected physicochemical parameters including alkalinity, total hardness (TH), turbidity, total suspended solids (TSS), temperature, pH, nitrate, nitrite, phosphate, electrical conductivity (EC), chloride, calcium, magnesium, and sulfate. To show the spatial and temporal variations of the selected parameters along the study area easily and objectively, Geographical Information System maps (GIS maps) were used. Results showed that the obtained values in winter of alkalinity, turbidity, electrical conductivity, and the concentration of calcium, magnesium, sulfate, nitrite, phosphate, chloride, and total suspended solids were higher as compared with the corresponding values in summer. On the other hand, temperature, total hardness, pH, and nitrate values were higher in summer as compared with the corresponding values in winter. The water quality of Tigris River throughout the study period was within the permissible limits of the Iraqi standards for drinking water.

Keywords:

Keywords: *GIS, Major and Minor Ions, Pollution, Tigris River, Water Quality.*

1. Introduction

Water, the main constituent of ecosystem is a precious national asset and a prime natural resources may be in the form of rain water, ground water, surface water (i.e. rivers, lakes, seas, etc.), and glaciers. The surface water is the most important forms of water for human activities such as drinking water, agriculture, industry, hydropower generation and other various sectors of the economy. In the world, one of the most primary environmental issues is water quality deterioration that resulted from the climatic change and increased pollution (Palmer and Bernhardt, 2004). Growing attention had been noticed during the last decades concerning water quality assessment of different rivers by analyzing the physicochemical and biological parameters of water and monitoring the spatial and temporal variations. Rani et al. 2011, studied the water quality of three rivers in terms of temporal variations and they found that the anthropogenic activities influencing the water quality of the studied surface area round the year. Basu and Lokesh, 2013, studied the temporal and spatial variations of River Kabini and they represented temporal variations by box plots. The study concluded that the river was rampantly polluted due to anthropogenic sources. Subin and Husna, 2013, assessed the water quality of Periyar river lets by assessing the impact of waste discharge at four selected sites. The study showed that the pollution load resulted from the disposal of solid waste into the river in addition to discharge of industrial and sewage waste. In Nigeria, Mustapha et al.2013, assessed the water quality of Jakarta River Basin by using the environmental techniques. The study established a strong relationship between BOD5 and COD and salinity and turbidity controlling the linear effects of NH4 and conductivity respectively. A paper dealt with water quality management in terms of monthly variations was presented by Parmar and Bhardwaj, 2014. The paper predicted that the estimation of future water quality parameters values can be done by using auto regressive integrated moving average model. Thomas et al. 2014, conducted a study to understand the impact of geochemical processes and other processes on the water quality of Muthirapuzah River. The study suggested seasonality over the hydrochemical composition. In 2017, Sharma et al. assessed the pollution of Yamuna River in terms of water quality using Geographical Information system (GIS). The study showed that the water river in Delhi is unsuitable for the human uses. This study aims to monitor the water quality of the Tigris River in Baghdad, Iraq by using the technique of a geographic information system (GIS). This technique allows creating parameter maps for easy and objective visual interpretation of the spatial and temporal variations for the obtained physicochemical data.

2. Materials ad Methods

Baghdad, the capital of Iraq 33° 20′ 0″ N, 44° 23′ 0″ E is located along the Tigris river. It is the largest city in Iraq according to its population in 2016 which was 8765000. The density of population and presence of many industries with their wastewater which discharged to the river in addition to different agricultural activities make the possibility of deterioration of its water quality is an indispensable fact. Therefore; monitoring of the Tigris River in this area is very important. Our study was conducted to cover eight different stations along the river starting from Al-Karkh, Shark Dijlah, Al-Karama, Al- Wathba, Al- Qadsya, and Al- Doura station. The water samples were collected during winter and summer seasons from the Tigris River for the period between 2005 and 2013 and analyzed in the laboratories of Baghdad Government according to the method adopted by American Public Health Association (APHA) for water and wastewater standards (APHA, 1998). The selected parameters were alkalinity mg/L as $CaCO_3$, total hardness (TH) mg/L as $CaCO_3$, turbidity NTU, total suspended solids (TSS) mg/L, temperature ºC, pH, nitrate mg/L, nitrite mg/L, phosphate mg/L, electrical conductivity (EC) µs/cm, chloride mg/L, calcium mg/L, magnesium mg/L and sulfate mg/L. In order to determine its suitability for drinking water, the obtained results were compared to the upper permissible limits recommended by Iraqi standard specification for drinking water No.417, modification No.2 of 2009 shown in table 1. To show the spatial and temporal variations of the obtained physicochemical data easily and objectively, the technique of a geographic information system (GIS) was used.

Table1: Iraqi Standards, 2009

Parameter	Unit	Limit
Alkalinity	mg/L	-
Total Hardness	mg/L	500
Turbidity	NTU	-
Total Suspended Solids	mg/L	-
Temperature	ºC	-
pH	-	6.5-8.5
Nitrate	mg/L	50
Nitrite	mg/L	3
Phosphate	mg/L	-
Electrical conductivity	µs/cm	-
Chloride	mg/L	350
Calcium	mg/L	150
Magnesium	mg/L	100
Sulfate	mg/L	400

3. Results and Discussion

Total suspended solids and Electrical Conductivity: The TSS parameter is considered a reliable and up-to-date measurement of the status of water resource quality to the decision makers in the water quality management field. The seasonal variation in TSS and EC are shown in fig.1 and 2 respectively.

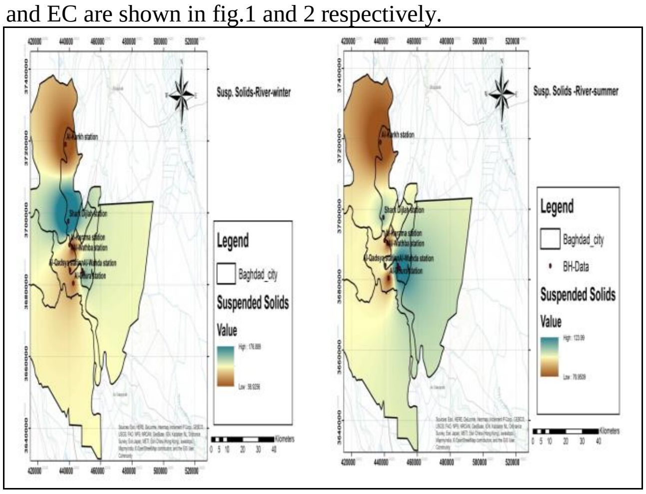


Fig. 1: Spatial and temporal variation in total suspended

In this study, the TSS in summer ranged between 76.95 and 123.99 mg/L, while in winter ranged between 58.925 and 176.889 mg/L. As can be noted from the figure, the minimum value appeared at Al-Karkh station throughout the study period, while the maximum value appeared at Shark Dijlah station during winter. The high value of suspended solids may be due to high levels of overland, debris flows, mass wasting, and high stream erosion (Davie, 2002, Moore *et al*. 2009). On the other hand, the electrical conductivity is used to measure the salinity of the water. The EC of river water ranged from 605.656 to 797.382µs/cm in summer and 686.259 to 974.898µs/cm in winter. As shown in fig. 2, the values were increased as the river moved downwards because of increasing the domestic sewage waste, the agricultural and industrial activities in the region. The maximum values were recorded in winter as the erosion process of the sedimentary rocks increased and then the interference between groundwater and surface water appeared.

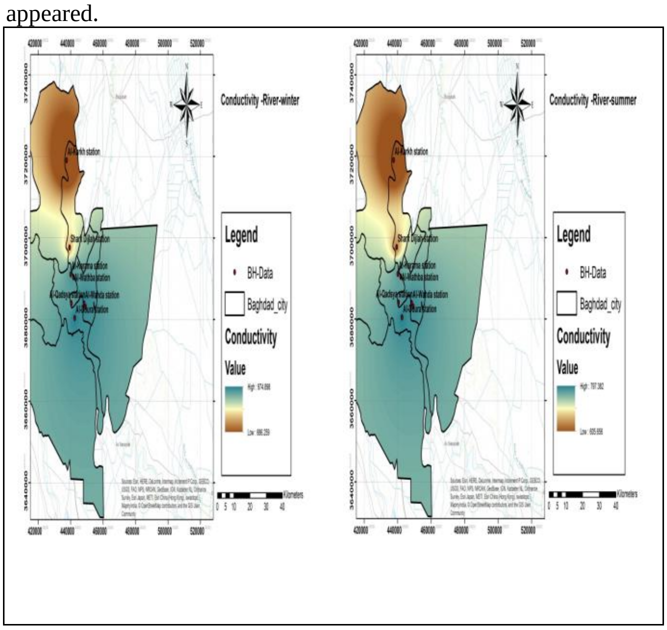


Fig. 2: Spatial and temporal variation in electrical conductivity

Temperature and pH: Temperatures of sampled Tigris water were convenient to the Iraqi climate with high values during summer season decreases towards winter season. Temperature varied from the highest value of 28.75ºC during summer to the lowest value of 16.356 ºC during winter. The minimum values throughout the study period were recorded at Al- Karama, Al-Doura and Al- Wathba Stations., while, the maximum values throughout the study period were recorded at Al- Karkh station as Shown in fig. 3 below.

During the study period, pH values ranged from 7.816 to 8.054 in summer and 7.843 to 7.979 in winter as shown in fig.4 below. These values show no abrupt spatial and temporal changes and the tendency of the Tigris river is towards alkaline nature. The maximum value was recorded during summer and it may be due to a high biological activity of the river (saravanakumar et al., 2008). The values of pH throughout the study period were within the permissible limits that recommended by the Iraqi standards.

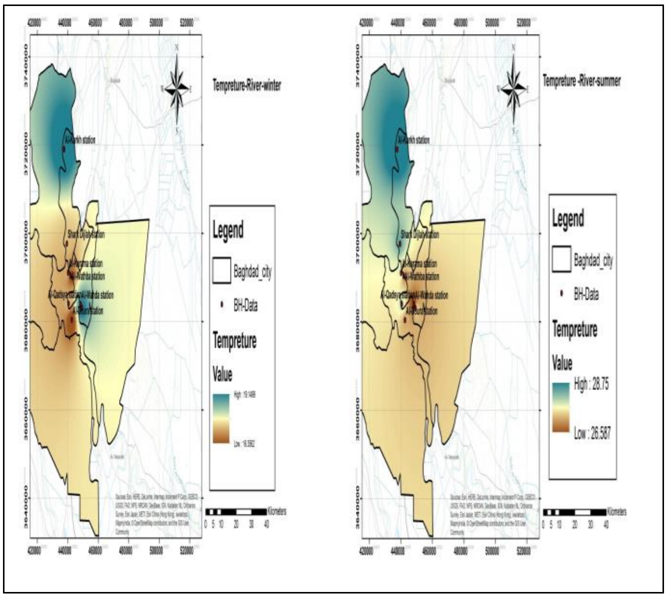


Fig. 3: Spatial and temporal variation in temperature

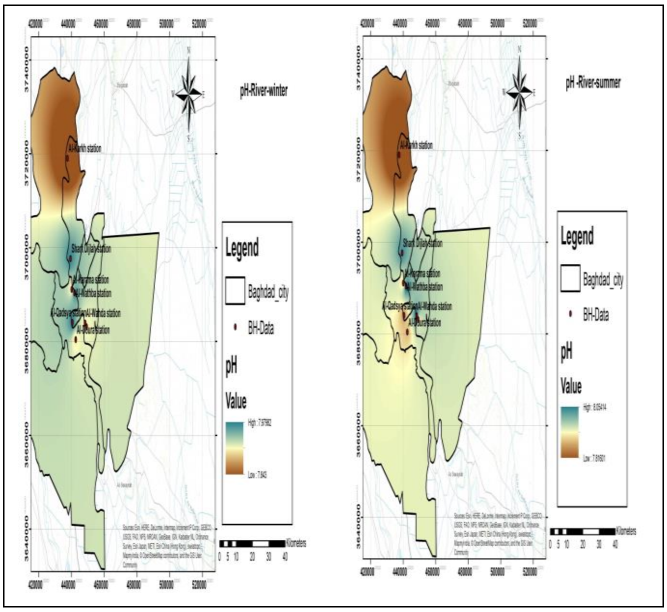


Fig. 4: Spatial and temporal variation in pH

Total Hardness: The presence of chlorides, sulfates, bicarbonates, and nitrates of magnesium and calcium refers to the total hardness of water (Kumar *et al*. 2010). It is usually expressed as the equivalent quantity of calcium carbonate (WHO, 2006). Fig. 5 shows that total hardness ranged from 130.451 to 152.909 mg/L as $CaCO_3$ in winter and 235.802 to 301.146 mg/L as $CaCO_3$ in summer. Throughout the study period, the least values were observed at Al- Karkh station, while the highest values were noted at downstream stations which may be attributed to the direct pollution caused by anthropogenic activities or from the natural accumulation of salts enter from contact with the geological formation and soils as well as the increase of evaporation at high temperature. The values of total hardness throughout the study period were less than the upper permissible limits that recommended by the Iraqi standards.

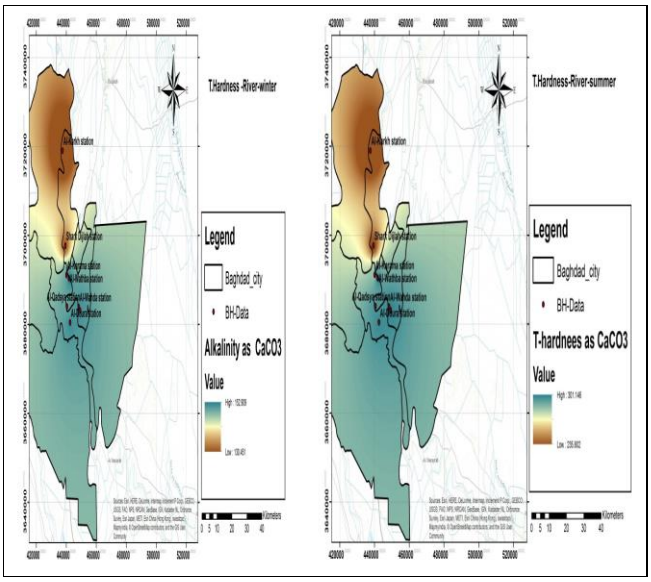


Fig. 5: Spatial and temporal variation in total hardness

Alkalinity: It is a measure of the water's capacity to neutralize acids. Minerals such as limestone are responsible to produce alkalinity. High pH values of water indicate the presence of carbonate, bicarbonate, and hydroxides. The main potential source of alkalinity is the natural processes of rock weathering. Alkalinity ranged from 131.001 to 149.542 mg/L as $CaCO_3$ and 130.451 to 152.909mg/L as $CaCO_3$ during summer and winter seasons respectively as shown in fig. 6. The highest value was recorded at Shark Dijlah station during winter, while the least value was recorded at Al- Karkh station. The highest value recorded in winter may be due to pollution by untreated domestic sewage and other anthropogenic activities.

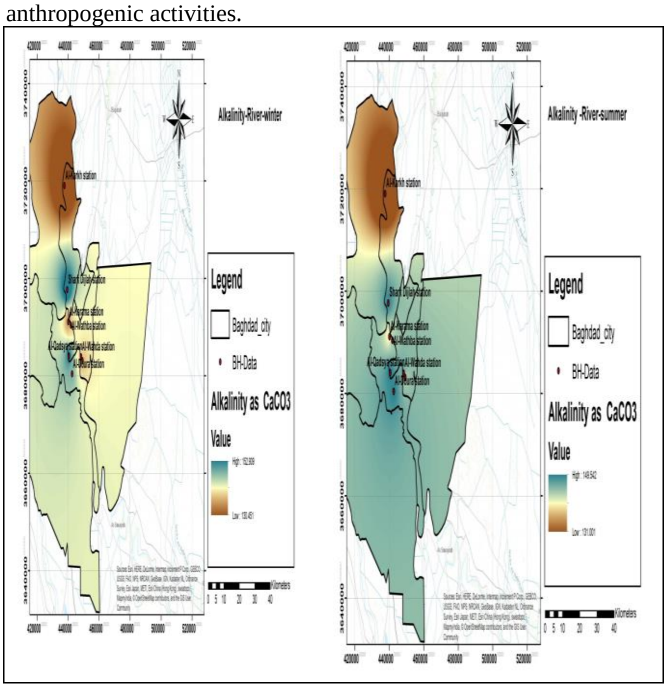


Fig. 6: Spatial and temporal variation in alkalinity

Turbidity: It is considered a health-related parameter (EPA, 2002). Suspended and colloidal matters comprise the main causes of water turbidity. The turbidity values ranged from 39.956 to 112.916 NTU and 51.63 to 74.236 NTU during winter and summer seasons respectively. Fig. 7 shows that the least value was recorded at Al- Karkh station increased with the flow direction to reach the highest value at Al – Doura station. During winter the high flow conditions occur causing the increase in suspended load carried by the river leading to high values of turbidity.

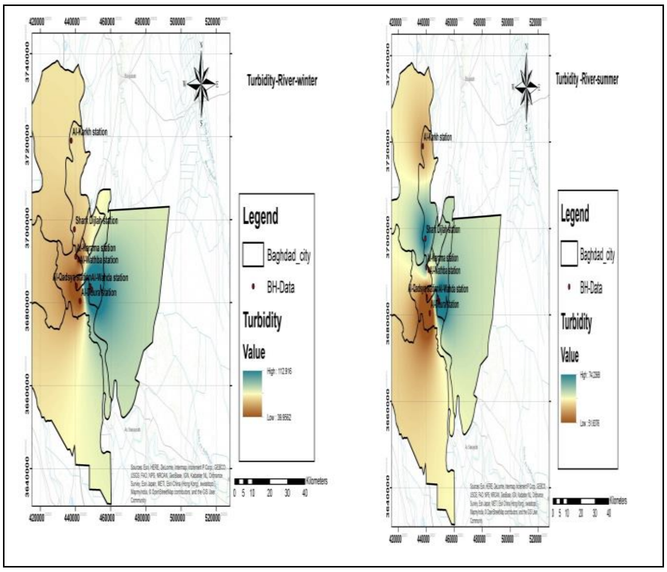
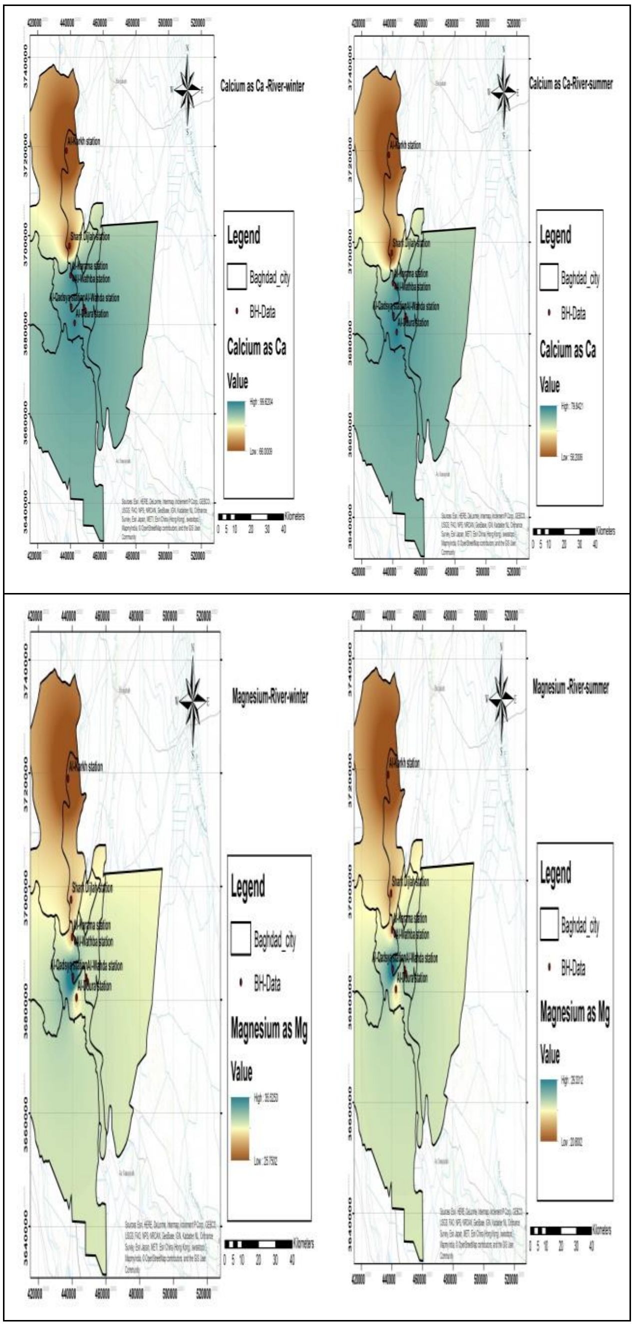


Fig. 7: Spatial and temporal variation in turbidity

Major Ions: One of the most familiar methods to reveal the nature of weathering is determining the major ion chemistry that is available in river waters. Calcium (Ca^{+2}) and magnesium (Mg^{+2}) were selected to represent the major cations, whilst chloride (Cl^{-1}) and sulfate ($SO4^{-2}$) were selected to represent the major anions. The concentration of (Ca) ranged from 66.00 to 99.62 mg /L and 58.2 to 79.84 mg/L during winter and summer seasons respectively. The corresponding values of (Mg) were 25.75 to 35.525 mg /L and 20.8 to 29.33 mg /L. On the other hand, concentrations of (Cl) ranged from 46.901 to 80.688 mg/L and 38.3 to 66.931 mg/L during winter and summer respectively. The corresponding values of (SO_4) were 138.956 to 256.926 mg/L and 106.502 to 201.138 mg/L. The cations and anions concentrations had the same increasing spatial pattern as they recorded the least values at Al- Karkh station and the values tend to increase as the river flows downwards till they reach the highest values at Al-Doura station as shown in fig 8 below. The four Major ions recorded the highest values during winter and the concentrations were within the permissible limits of Iraqi standards.

Minor Ions and Nutrients: Nitrate (NO_3), nitrite (NO_2) and phosphate (PO_4) were selected to represent the minor ions. The excessive concentration of nutrients is an indication of increasing the domestic sewage and other anthropogenic activities and may lead to eutrophication. In our study, concentration of (NO_3) ranged from 0.5249 to 0.8400 mg/L and 0.512 to 0.898 mg/L during winter and summer seasons respectively, while the concentration of (NO_2) ranged from 0.0046 to 0.0158 mg/L, and 0.0026 to 0.0116 mg/L during winter and summer seasons respectively. The corresponding values of (PO_4) were 0.010 to 0.1446 mg/L and 0.0116 to 0.1346 mg/L as shown in fig.9 below. Throughout the study period, (NO_2) and (PO_4) had the same increasing spatial pattern as the least concentration of them was observed at Al- Karkh station and the value tends to increase as the river flows downwards till it reaches the highest values at Al- Doura station. Also, they had the same temporal pattern as the highest values observed during winter. On the other hand, the concentration of (NO_3) increased with flow direction to Al- Qadsya station and then tends to decrease till it reached Al- Doura station. The highest value of (NO_3) was recorded during summer. The concentrations of nitrate and nitrite during the study period were within the permissible limits of Iraqi standards.



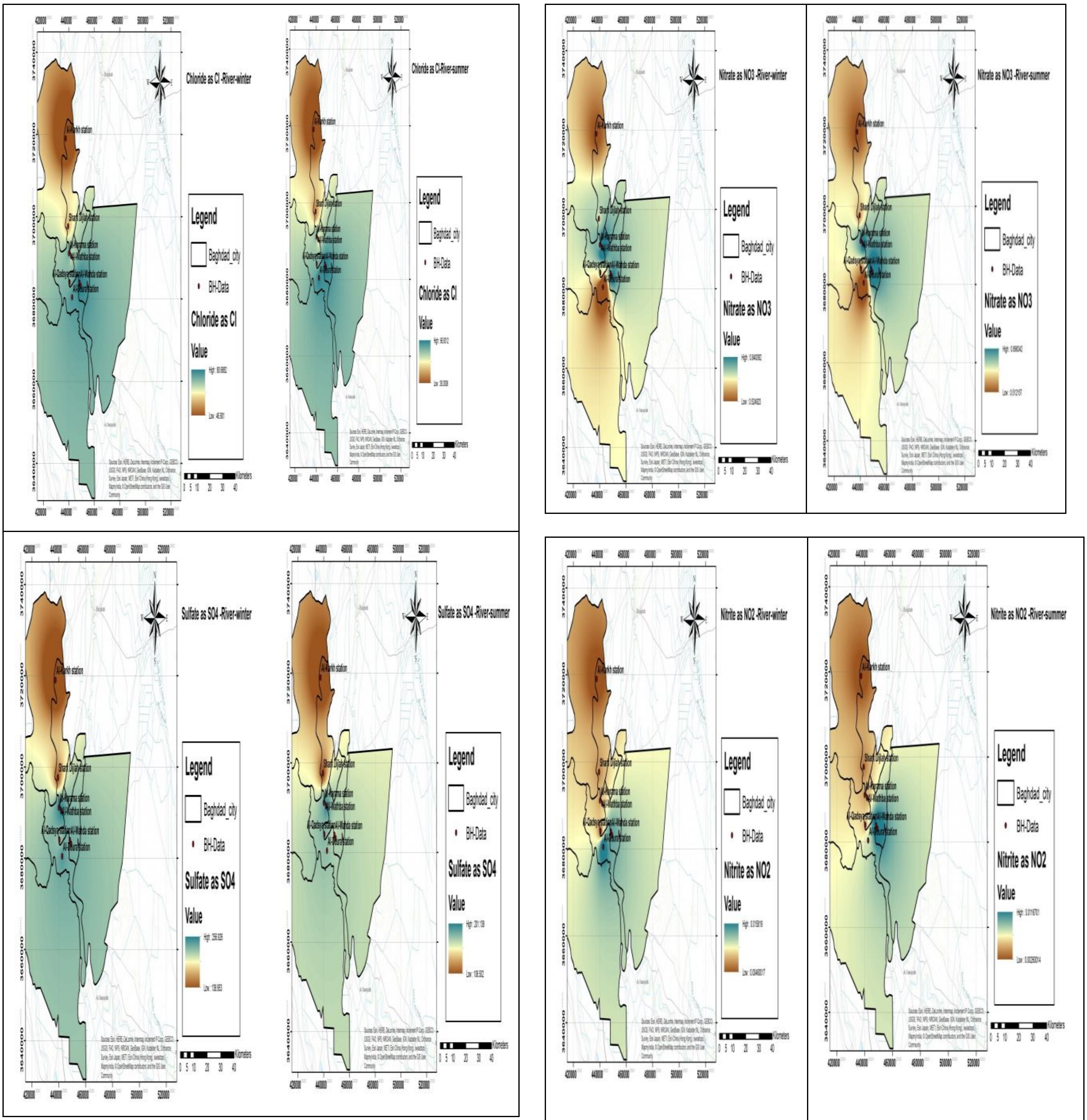


Fig. 8: Spatial and temporal variation in major ions

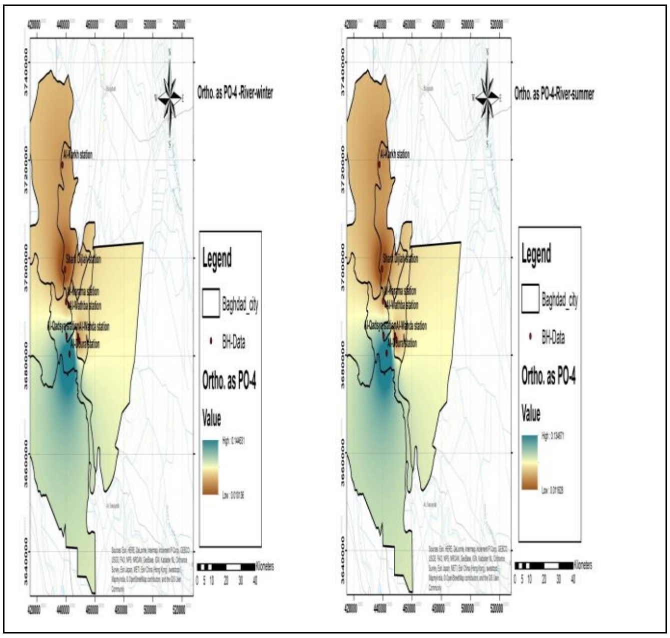


Fig.9: Spatial and temporal variation in minor ions

4. 4. Conclusion

Monitoring of water resources quality is a matter of great importance as it provides an evaluation of resource status and its suitability for human activities as well as the aquatic system. In the last decades, this field of knowledge witnessed growing attention around the world using different methodologies and aspects. Our study adopted using GIS technique to simplify the overall representation procedure and facilitate the visual interpretation of the spatial and temporal variations for the obtained physicochemical data during the period lasting from 2005 to 2013 along the selected study area. The main conclusions of this study are:

Temporally, the obtained values in winter of alkalinity, turbidity, EC and the concentration of calcium, magnesium, sulfate, nitrite, phosphate, chloride, and total suspended solids were higher as compared with the corresponding values in summer. On the other hand, the temperature, total hardness, pH, and nitrate values were higher in summer as compared with the corresponding values in winter. Spatially, most of the high values were observed at the stations downstream and this is may be due to increasing the agricultural and industrial activities as well as the discharges of untreated or partially treated domestic sewage into the river. The obtained values of the selected parameters throughout the study period were within the permissible limits of the Iraqi standards and this is indicating the suitability of the river for drinking water.

References

[1] APHA. (1998). Standard methods for the examination of water and wastewater analysis. 20thEdn., American Public Health Association, AWWA.

[2] Basu, S., & Lokesh, K. S. (2013). Spatial and temporal variations of river water quality: A case study of River Kabini and Nanjangud in Karnataka. International Journal of Water Resources and Environmental Engineering, 5(10): 591-566.Central Organization for Standardization and Quality Control, 2009. Iraqi standard of drinking water No. 417; modification No. 2.

[3] Davie, T. (2002). Fundamentals of Hydrology, 2nd Edn., Routledge.

[4] EPA. (2002). National recommended water quality criteria, http://www.epa.gov/watersciene/pc/revcom.pdh

[5] Kumar, A., Bisht, B. S., Amitabh, T., & Deepika, C. (2010). Physicochemical and microbial analysis of ground water from different regions of doon valley. International Journal of Environmental Science and Technology, 5(3):433-440.

[6] Moore, R. D., Fleming, B. M., Wheate, R., Fountain, A., Stahl, K., Holm, K.& Jakob, M. (2009). Glacier change in western North America: influences of hydrology geomorphic hazards and water quality. Hydrological Processes, 23: 42-61.

[7] Mustapha, A., Aris, A.Z., Juahir, H., Ramli, M.F., & Kura, N.U. (2013). River water quality assessment using environmental techniques: a case study of Jakara River Basin. Environmental Science and Pollution Research, 20:5630-5644.

[8] Palmer, M.A., & Bernhardt, E.S. (2004). Ecological science and sustainability for a crowded planet. Report from the Ecological Society of America, www.sea.org/ecovisions.

[9] Parmar, K.S.,& Bhardwaj, R. (2014). Water quality management using statistical analysis and time-series prediction model. Applied Water Science, DOI 10.1007/s ,13201-014-0159-9.

[10] Rani, N., Sinha,R.K., Prasad, K. & Kedia, D.K. (2011). Assessment of temporal variation in water quality of some important rivers in middle Gangetic plains, Environmental Monitoring and Assessment, 174:401-415.

[11] Saravanakumar, A., Rajkumar, M., Sesh Serebiah, J. & Thivakaran, G.A. (2008). Seasonal variations in physicochemical characteristics of water, sediment and soil texture in arid zone mangroves of Kachchh-Gujarat. Journal of Environmental Biology, 29:725-732.

[12] Sharma, S., Jha, P.K., Ranjan, M.R., Singh, U.K., & Jindal, T. (2017). Water quality monitoring of Yamuna River by using GIS-based water quality index in Delhi, India. International Journal of Current Microbiology and Applied Sciences, 6(2):1249-1263.

[13] Subin, M.P., & Husna, A.H. 2013. An Assessment on the impact of the waste discharge on water quality of Periyar River Lets in certain selected sites in the northern part of Ernakulam District in Kerala, International Research Journal of Environmental Sciences, 2(6):76-84

[14] Thomas, J., Joseph, S., Thrivikramji, K. P., Manjusree, T. M., & Arunkumar, K.S. (2014). Seasonal variation in major ion chemistry of a tropical mountain river, the southern Western Ghats, Kerala, India. Environmental Earth Sciences, 71: 2333-2351.

[15] Weiner, E. R. (2008). Applications of environmental aquatic chemistry: A practical guide, 2nd Edn. CRC Press: Boca Raton.

[16] WHO. (2006). Guidelines for drinking water quality. 2nd Edn., vol.1, recommendations, Geneva: 595.